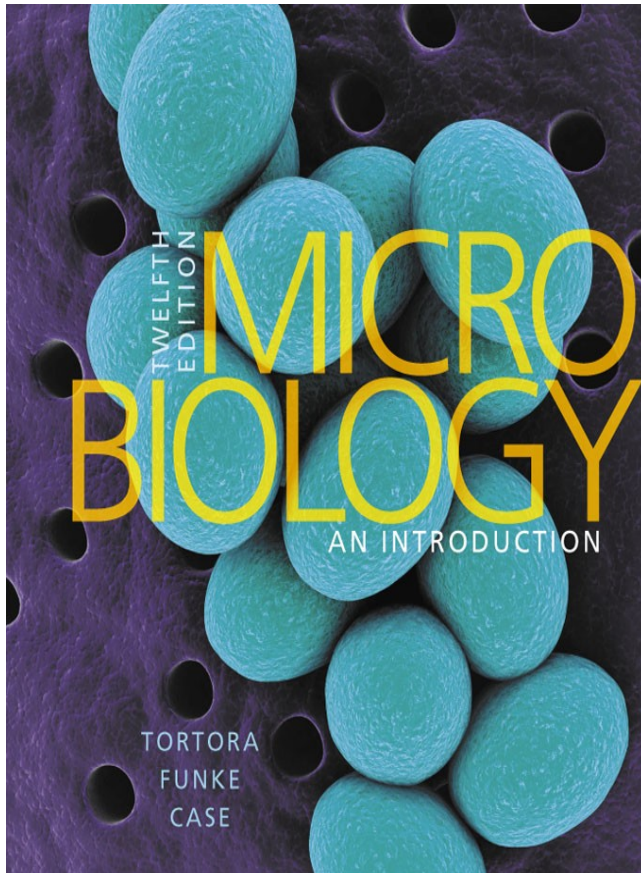


Microbiology an Introduction

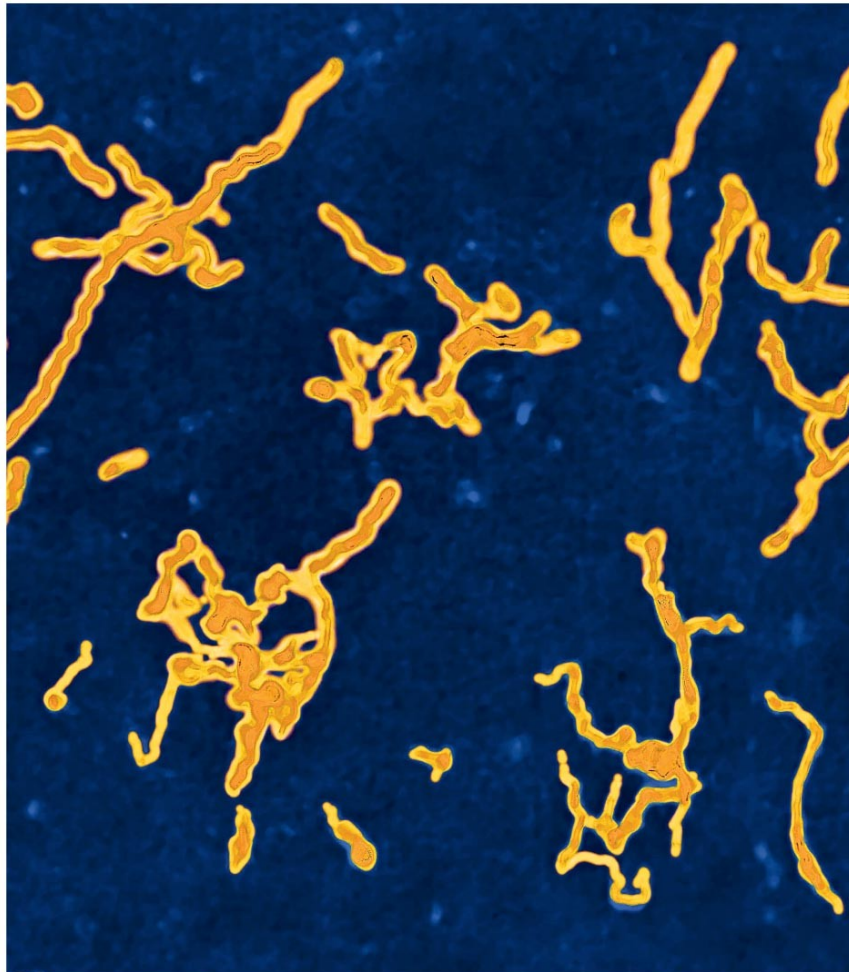
Twelfth Edition



Chapter 26

Microbial Diseases of the Urinary and Reproductive Systems

Leptospira Interrogans



Structure and Function of the Urinary System (1 of 2)

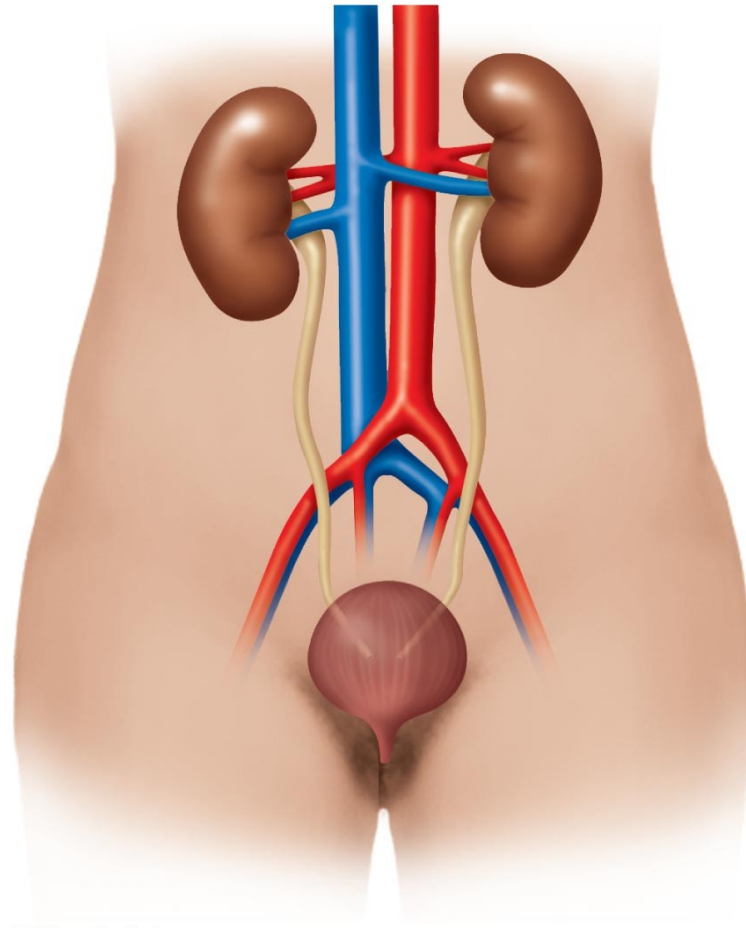
Learning Objective

26-1 List the antimicrobial features of the urinary system.

Structure and Function of the Urinary System (2 of 2)

- **Urinary system**
 - Two kidneys
 - Two ureters
 - One urinary bladder
 - One urethra
- Infection prevented by:
 - Valves that prevent backflow to the kidneys
 - Acidity of urine
 - Mechanical flushing

Figure 26.1 Organs of the human urinary system, shown here in the female



Check Your Understanding-1

Check Your Understanding

- ✓ Does the pH of urine facilitate the growth of most bacteria?
26-1

Structure and Function of the Reproductive Systems (1 of 3)

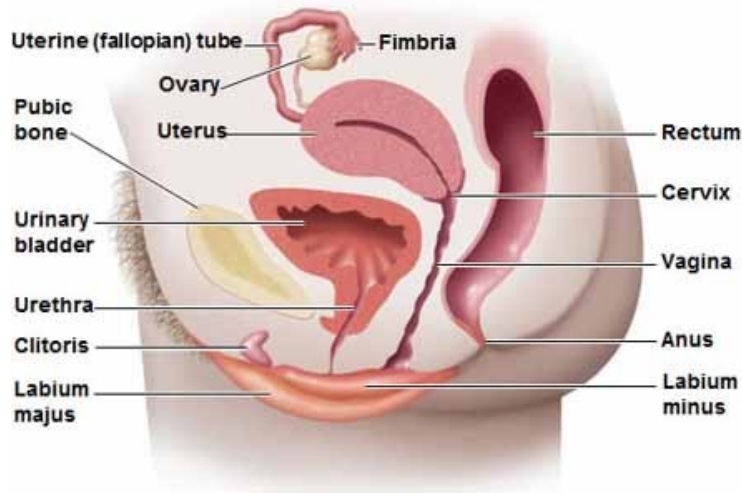
Learning Objective

26-2 Identify the portals of entry for microbes into the female and male reproductive systems.

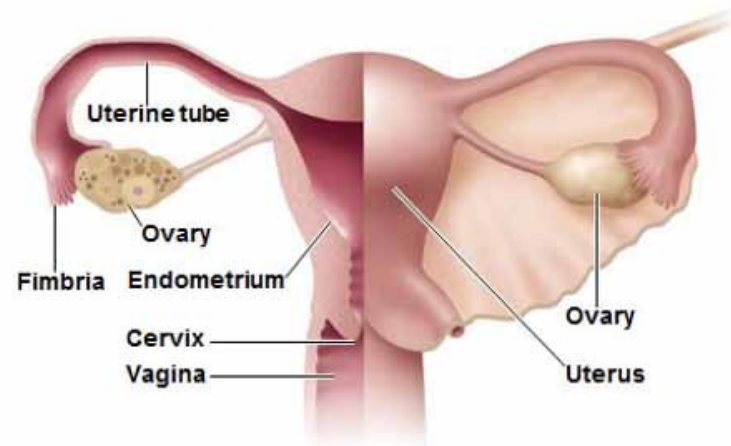
Structure and Function of the Reproductive Systems (2 of 3)

- **Female reproductive system**
 - Two ovaries
 - Two uterine (fallopian) tubes
 - The uterus, including the cervix
 - The vagina
 - External genitals (vulva)

Figure 26.2 Female reproductive organs



(a) Side view section of female pelvis showing reproductive organs.



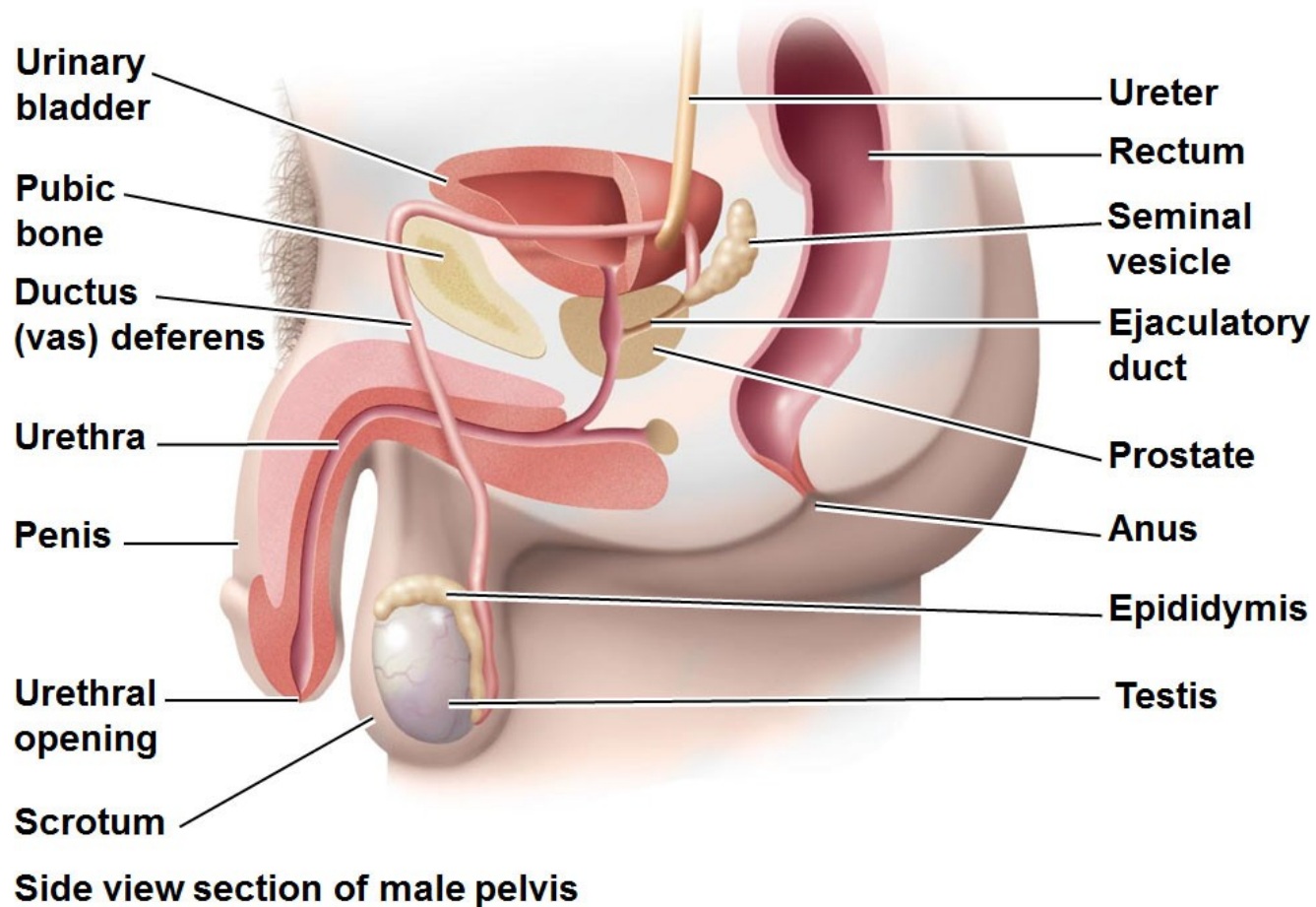
(b) Front view of female reproductive organs, with the uterine tube and ovary to the left in the drawing sectioned. The fimbriae move to create fluid movement that moves the egg into the uterine tube.

Structure and Function of the Reproductive Systems (3 of 3)

- **Male reproductive system**

- Two testes
- System of ducts
 - Epididymis
 - Ductus (vas) deferens
 - Ejaculatory duct
 - Urethra
- Accessory glands
- Penis

Figure 26.3 Male reproductive and urinary organs



Check Your Understanding-2

Check Your Understanding

- ✓ Look at Figure 26.2. Is a microbe entering the female reproductive system (the uterus, etc.) necessarily also entering the bladder, causing cystitis?

26-2

Normal Microbiota of the Urinary and Reproductive Systems (1 of 2)

Learning Objective

26-3 Describe the normal microbiota of the upper urinary tract, the male urethra, and the female urethra and vagina.

Normal Microbiota of the Urinary and Reproductive Systems (2 of 2)

- Urinary bladder and upper urinary tract are sterile
- Predominant microbes of the vagina:
 - Lactobacilli
 - Produce H_2O_2 and lactic acid
 - Growth promoted by estrogen
 - Streptococci, anaerobes, some gram-negatives
 - **Candida albicans** yeast
- Male urethra is usually sterile

Check Your Understanding-3

Check Your Understanding

- ✓ What is the association between estrogens and the microbiota of the vagina?
26-3

Bacterial Diseases of the Urinary System (1 of 2)

Learning Objectives

26-4 Describe the modes of transmission for urinary and reproductive system infections.

26-5 List the microorganisms that cause cystitis, pyelonephritis, and leptospirosis, and name the predisposing factors for these diseases.

Bacterial Diseases of the Urinary System (2 of 2)

- Urethritis
 - An inflammation of the urethra
- **Cystitis**
 - An inflammation of the urinary bladder
- Ureteritis
 - Infection of the ureters
- **Pyelonephritis**
 - An inflammation of one or both kidneys
- 7 million urinary tract infections annually
 - Most due to **Escherichia coli**

Cystitis

- Commonly caused by **E. coli**; also **Staphylococcus saprophyticus**
- Dysuria (difficult or painful urination); pyuria
- Eight times more common in women than men
 - Due to the short length of the urethra
- Diagnosis: >100 CFU/ml of potential pathogens and a positive leukocyte esterase (LE) test
- Treatment with trimethoprim-

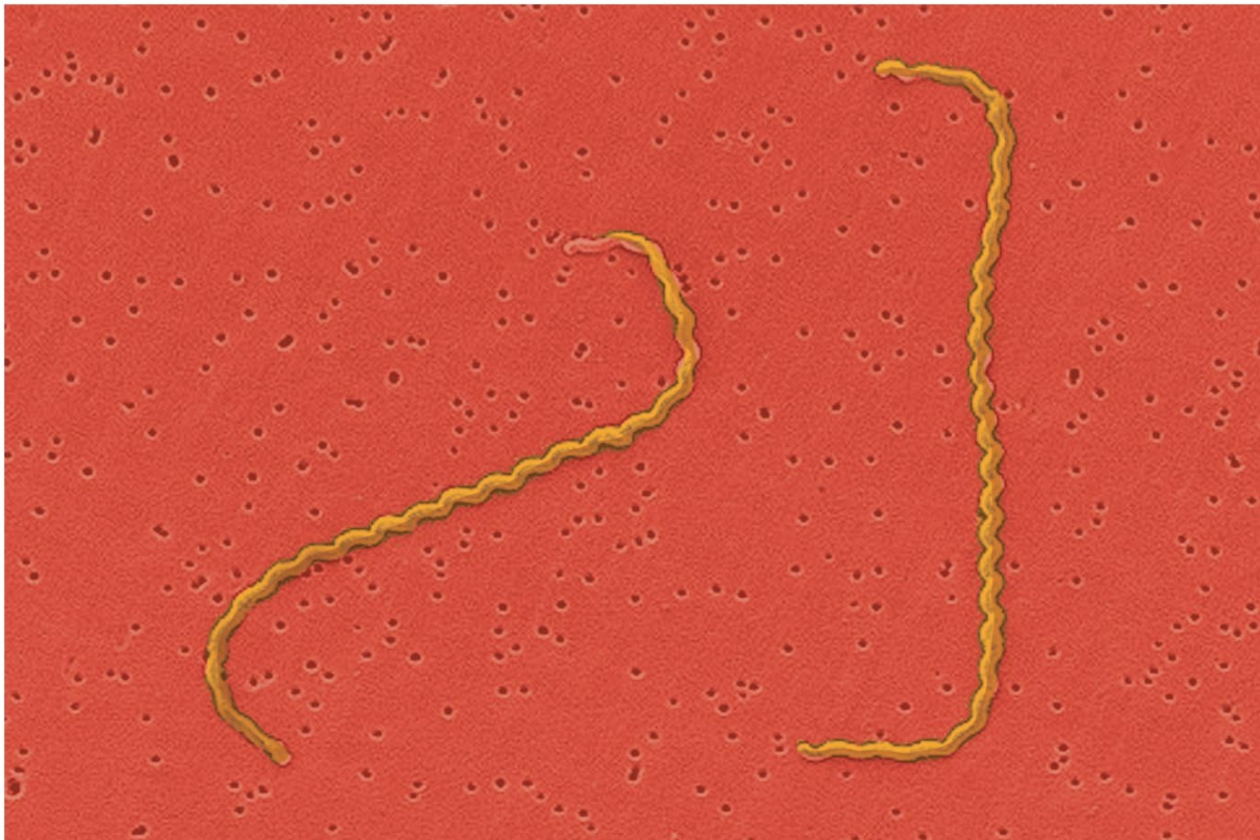
Pyelonephritis

- 75% of cases caused by **E. coli**
- Fever and back or flank pain
- Generally results in bacteremia
- Can form scar tissue in kidneys and become life- threatening
- Diagnosis: $>10,000$ CFU/ml and a positive LE test
- Treatment with cephalosporin

Leptospirosis

- Caused by **Leptospira interrogans**
 - Fine spiral; stains poorly; obligate aerobe
- Transmitted by skin/mucosal contact from urine-contaminated water from domestic or wild animals
- Headaches, muscular aches, fever
 - Kidney failure (Weil's disease)
 - Pulmonary hemorrhagic syndrome
- Diagnosed with a rapid serological test
- Treatment with doxycycline

Figure 20.4 Leptospira Interrogans, the Cause of Leptospirosis



SEM

1 μ m

Diseases in Focus: Bacterial Diseases of the Urinary System

- A 20-year-old woman feels a stinging sensation when urinating and feels an urgent need to urinate, even if very little urine is excreted. Lactose-fermenting, gram-negative rods are cultured from her urine.
- Can you identify infections that could cause these symptoms?

Diseases in Focus 26.1 (1 of 2)



Diseases in Focus 26.1 (2 of 2)

Disease	Pathogen	Symptoms	Diagnosis	Treatment
Cystitis (urinary bladder infection)	Escherichia coli, Staphylococcus saprophyticus	Difficulty or pain in urination	.100 CFU/ml potential pathogens and + LE test	Trimethoprim sulfamethoxazole
Pyelonephritis (kidney infection)	Primarily E. coli	Fever; back or flank pain	.104 CFU/ml And + 1 LE test	Cephalosporin
Leptospirosis (kidney infection)	Leptospira interrogans	Headaches, muscular aches, fever; kidney failure a possible complication	Serological test	Doxycycline

Check Your Understanding-4

Check Your Understanding

- ✓ Why is urethritis, an infection of the urethra, frequently preliminary to further infections of the urinary tract?
26-4
- ✓ Why is **E. coli** the most common cause of cystitis, especially in females?
26-5

Bacterial Diseases of the Reproductive Systems (1 of 2)

Learning Objective

26-6 List the causative agents, symptoms, methods of diagnosis, and treatments for gonorrhea, nongonococcal urethritis (NGU), pelvic inflammatory disease (PID), syphilis, lymphogranuloma venereum (LGV), chancroid, and bacterial vaginosis.

Bacterial Diseases of the Reproductive Systems (2 of 2)

- **Sexually transmitted diseases (STDs)**
 - Also known as **sexually transmitted infections (STIs)**
 - Often no signs or symptoms
 - Over 30 types of infections
 - 15 million new cases in the United States annually
 - Treatment with antibiotics and prevented with condoms

Big Picture: STI Home Test Kits

(1 of 2)

- Collect samples at home and mail to a lab
 - Screens for chlamydia, gonorrhea, and trichomoniasis
 - Results in 1–2 weeks
 - Positive tests receive referrals to clinics
- Test for HIV
 - OraQuick: oral test
- Test for urinary tract infections
 - Uritest dipstick test

Big Picture pg. 752



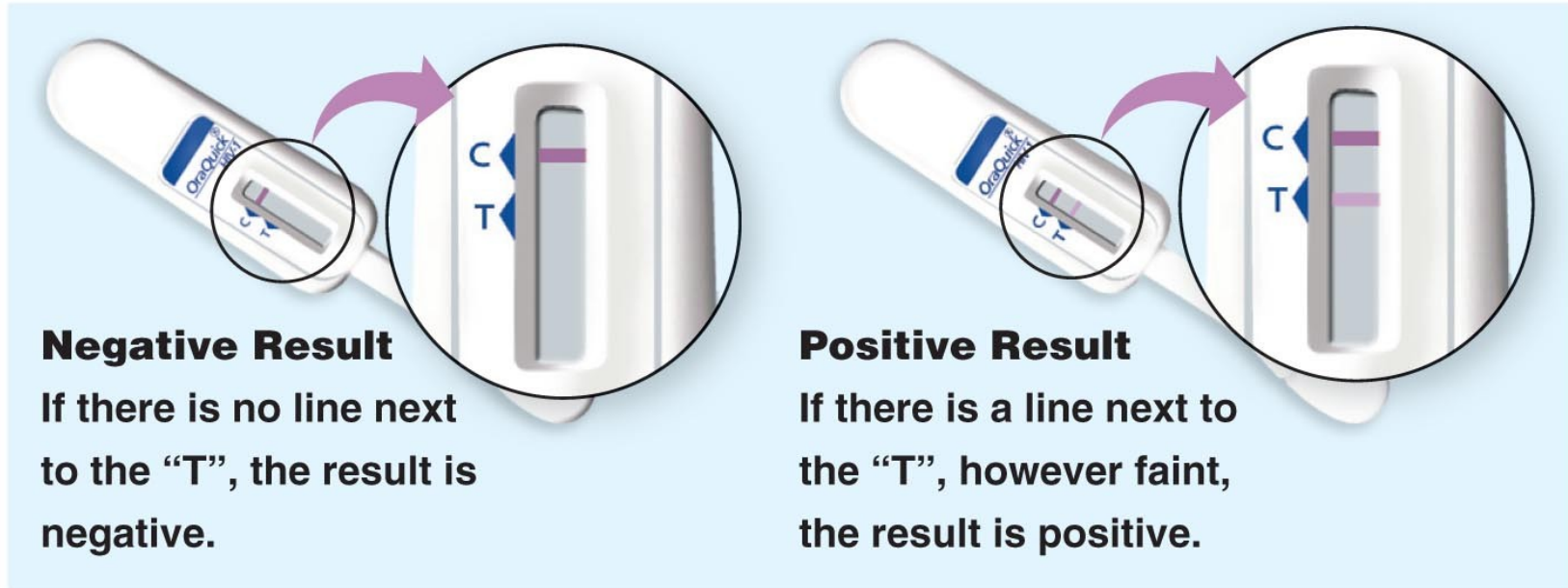
Female test kit contents for “I Want the Kit”

Big Picture: STI Home Test Kits

(2 of 2)

- Pros of at-home testing
 - More cases are diagnosed
 - Better access for patients
 - Quicker treatment
- Cons of home-testing
 - Cost
 - Privacy
 - Not all home test kits are equally accurate

Big Picture pg. 753

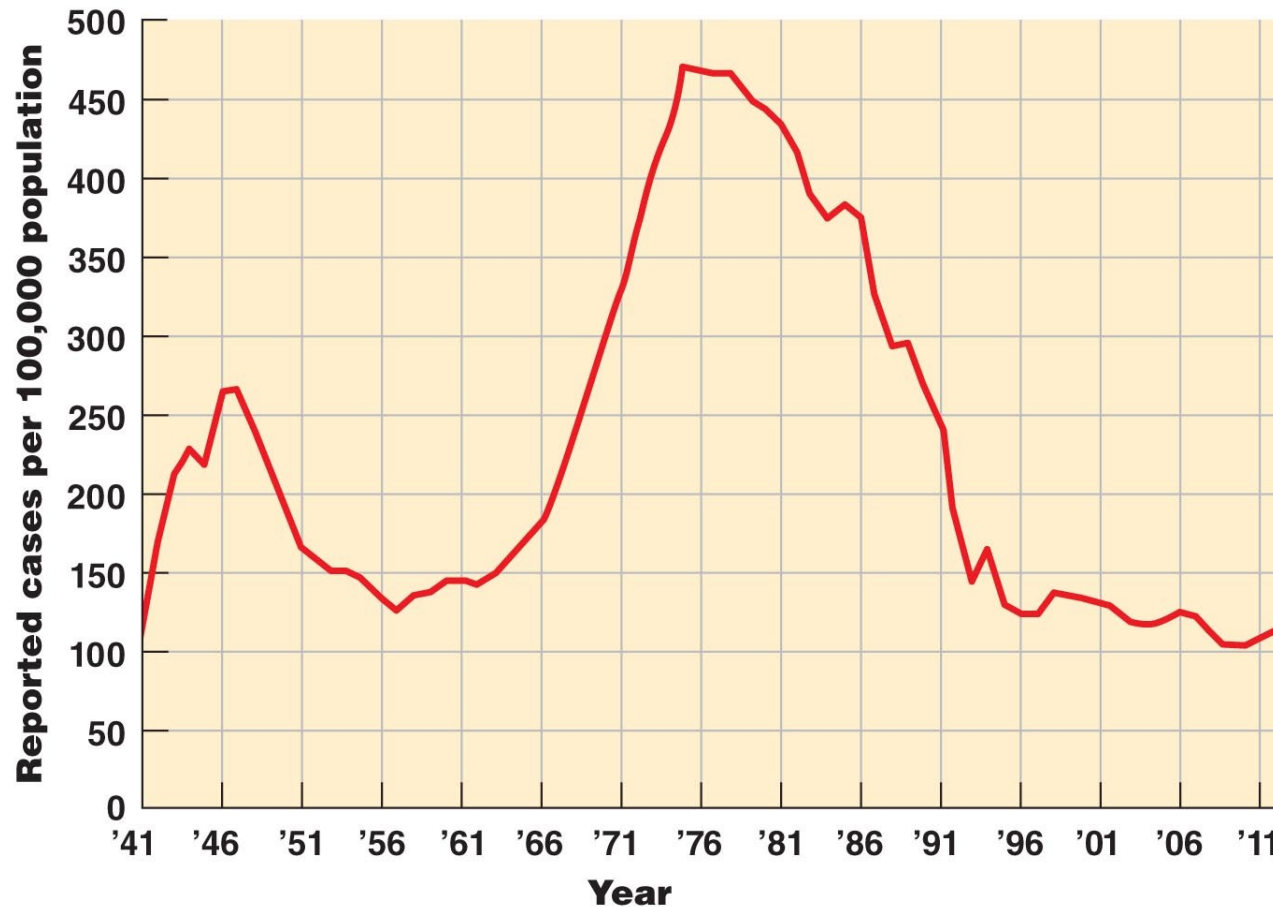


A positive OraQuick HIV test contains a synthetic HIV gp-41 protein. If the sample contains antibodies against gp-41, the T strip changes color due to an enzyme reaction.

Gonorrhea (1 of 3)

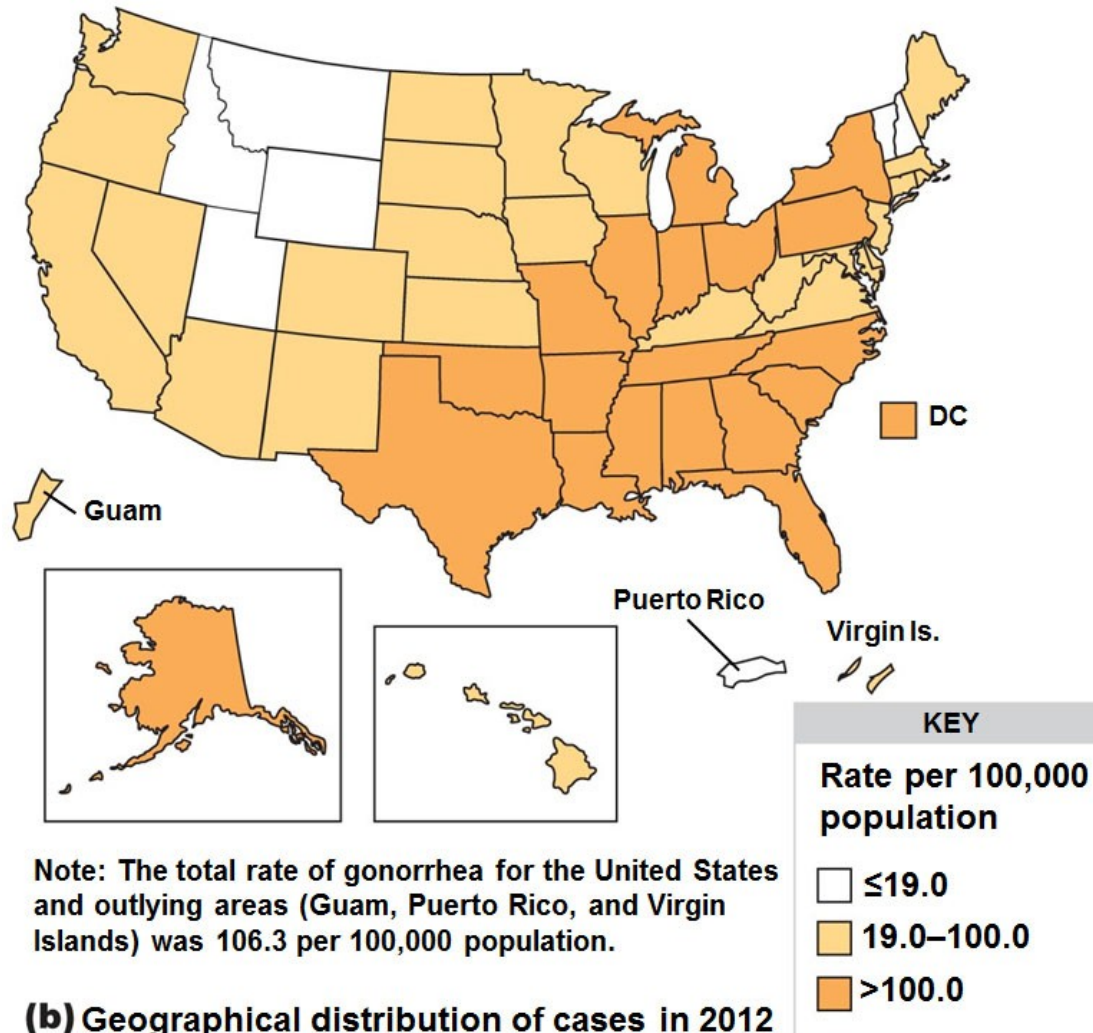
- Caused by **Neisseria gonorrhoeae**
 - Gram-negative diplococcus
- 300,000 cases in the United States annually
- Attaches to the epithelial mucosa by the fimbriae
 - Invades the spaces between the columnar epithelial cells
 - Causes inflammation
 - Forms pus
 - **Pharyngeal gonorrhea** and **anal gonorrhea**

Figure 26.5a The U.S. Incidence and Distribution of Gonorrhea



(a) Incidence of gonorrhea in the United States, 1941–2013

Figure 26.5b The U.S. Incidence and Distribution of Gonorrhea



Gonorrhea (2 of 3)

- Symptoms
 - Men: painful urination and discharge of pus; epididymitis
 - Women: fewer symptoms; pelvic inflammatory disease
- If left untreated, may disseminate and become systemic
 - Endocarditis
 - Meningitis
 - Arthritis
- **Ophthalmia neonatorum:** infant blindness due to a gonorrheal infection of the eyes

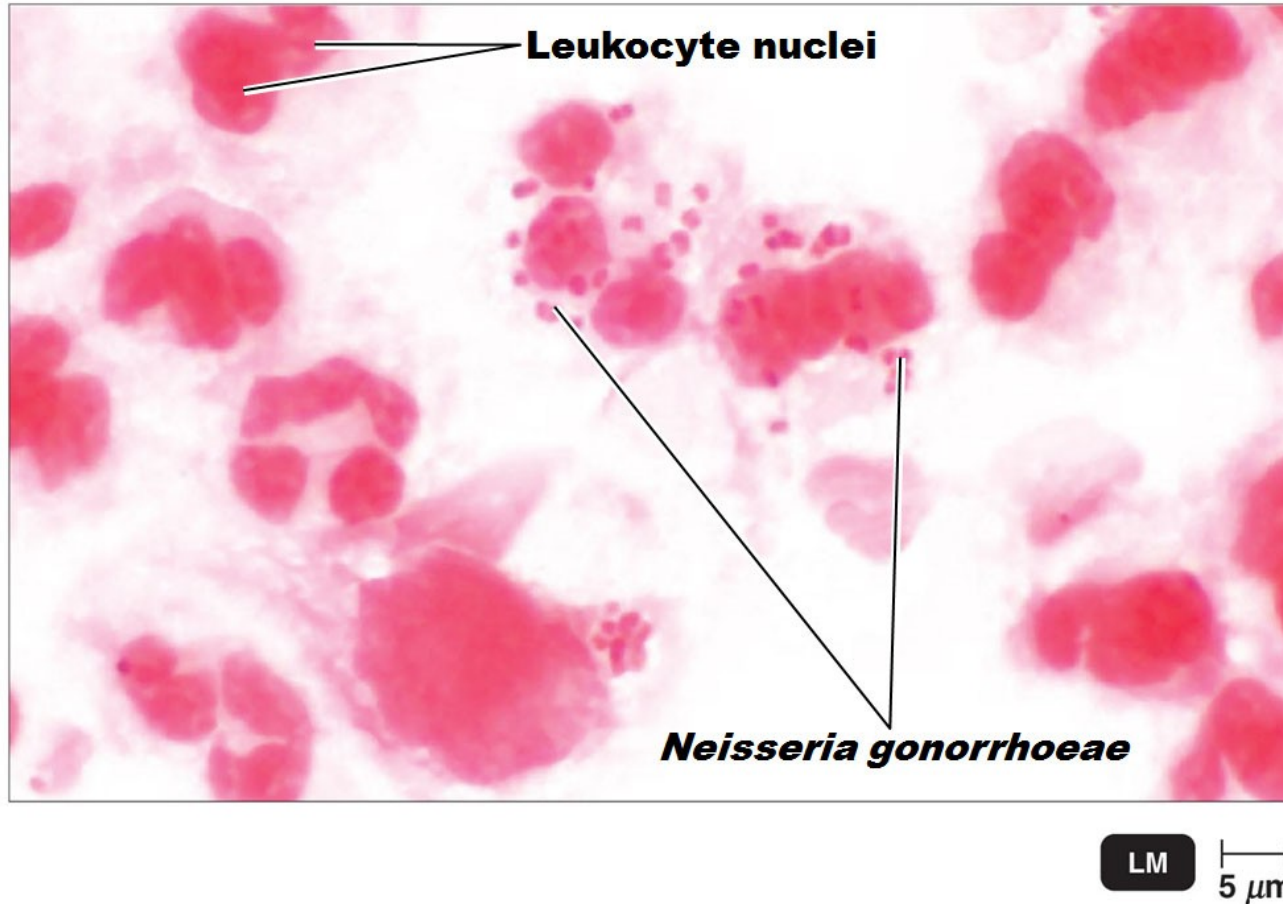
Figure 26.6 Pus-Containing Discharge from the Urethra of a Man with an Acute Case of Gonorrhea



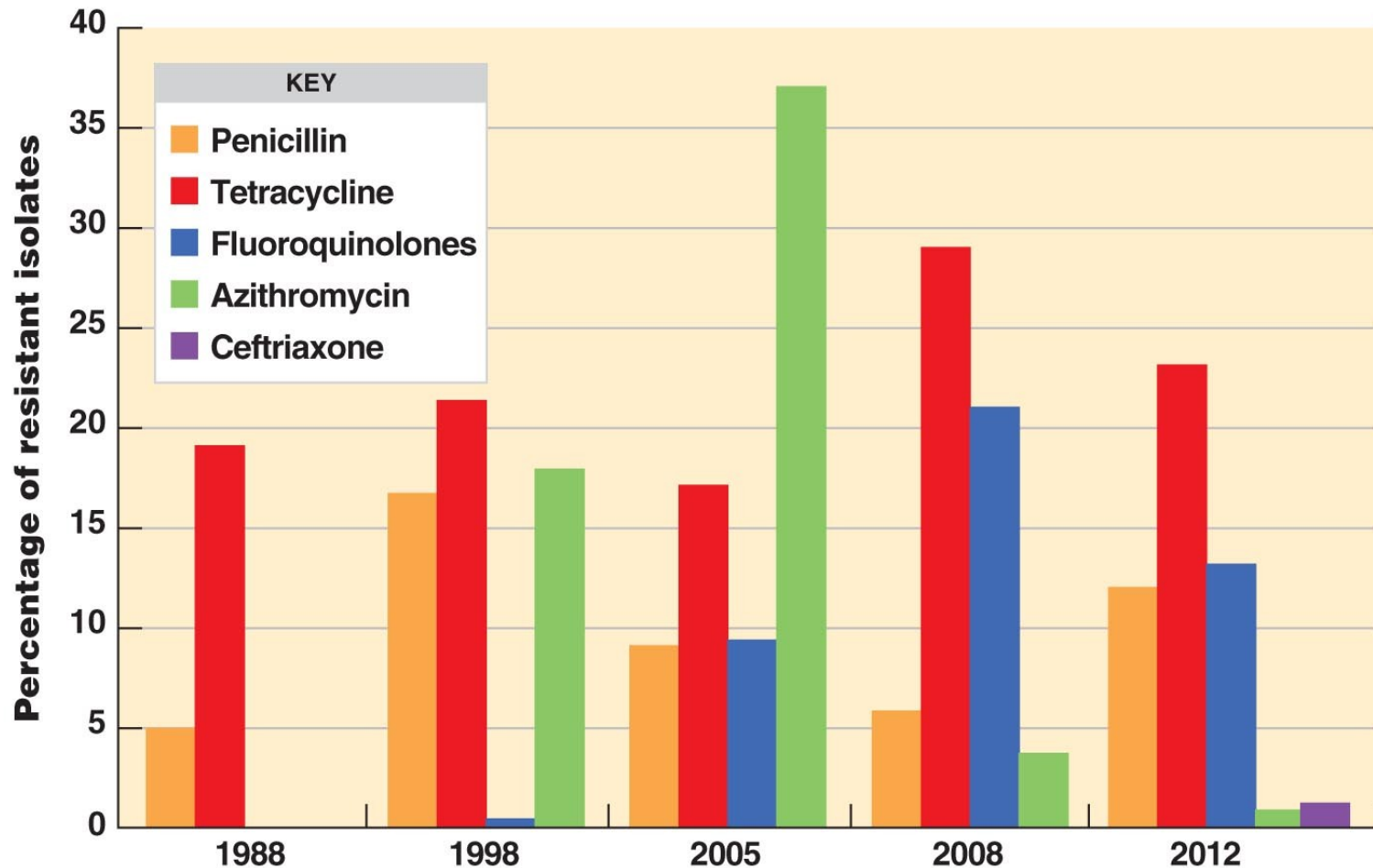
Gonorrhea (3 of 3)

- No adaptive immunity
 - Antigenic variability
 - Opa proteins bind to T cell receptors, preventing activation and immunological memory
- Diagnosis with Gram stain, ELISA, or monoclonal antibodies
- Treatment first with cephalosporins
 - Fluoroquinolones not recommended due to resistance

Figure 26.7 A Smear of Pus from a Patient with Gonorrhea



Clinical Focus 26.1



Nongonococcal Urethritis (NGU)

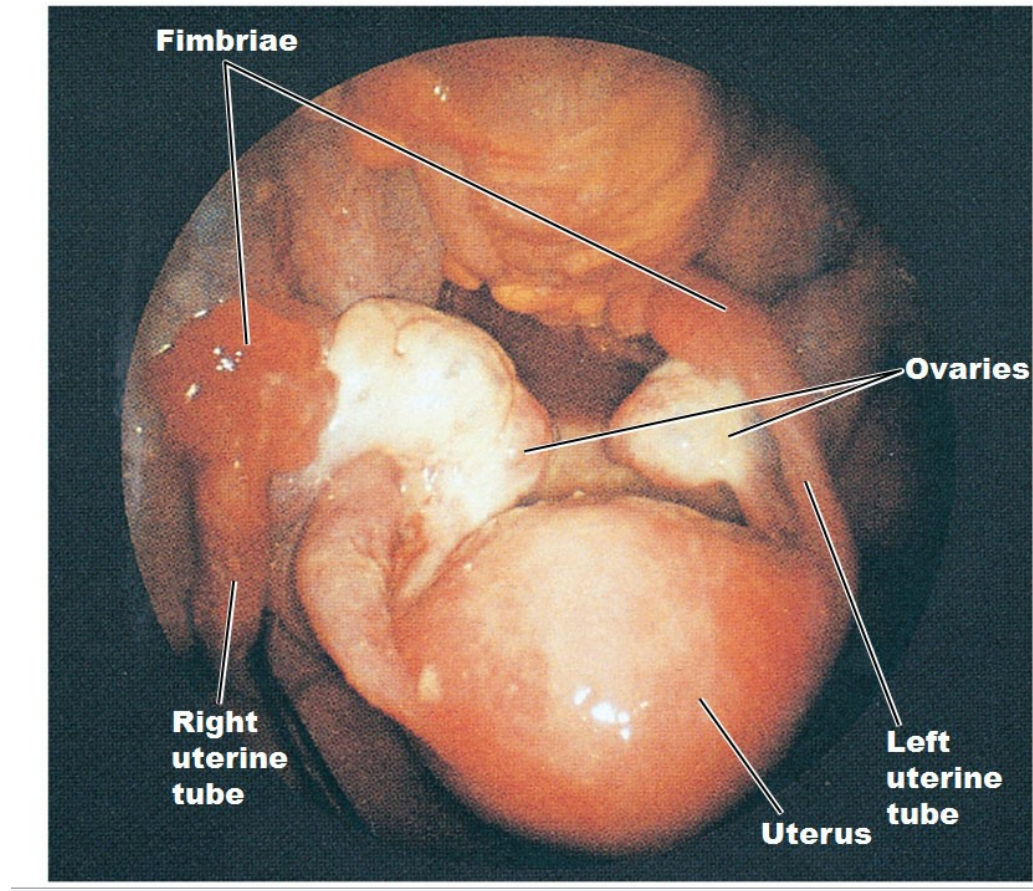
- **Nonspecific urethritis (NSU)**
 - Any inflammation of the urethra not caused by **N. gonorrhoeae**
- Caused by:
 - **Chlamydia trachomatis**
 - **Mycoplasma hominis**
 - **Ureaplasma urealyticum**
- Painful urination and watery discharge; often asymptomatic; pelvic inflammatory disease (PID) in women
- Diagnosis: culture or PCR
- Treatment with doxycycline and azithromycin



Pelvic Inflammatory Disease (PID)

- Extensive bacterial infection of the female pelvic organs
- Polymicrobial infection, usually:
 - **N. gonorrhoeae**
 - **C. trachomatis**
- Chronic abdominal pain
- **Salpingitis:** infection of the uterine tubes
 - Most serious form of PID
 - Scarring can cause infertility or ectopic pregnancy
- Treatment with doxycycline and cefoxitin

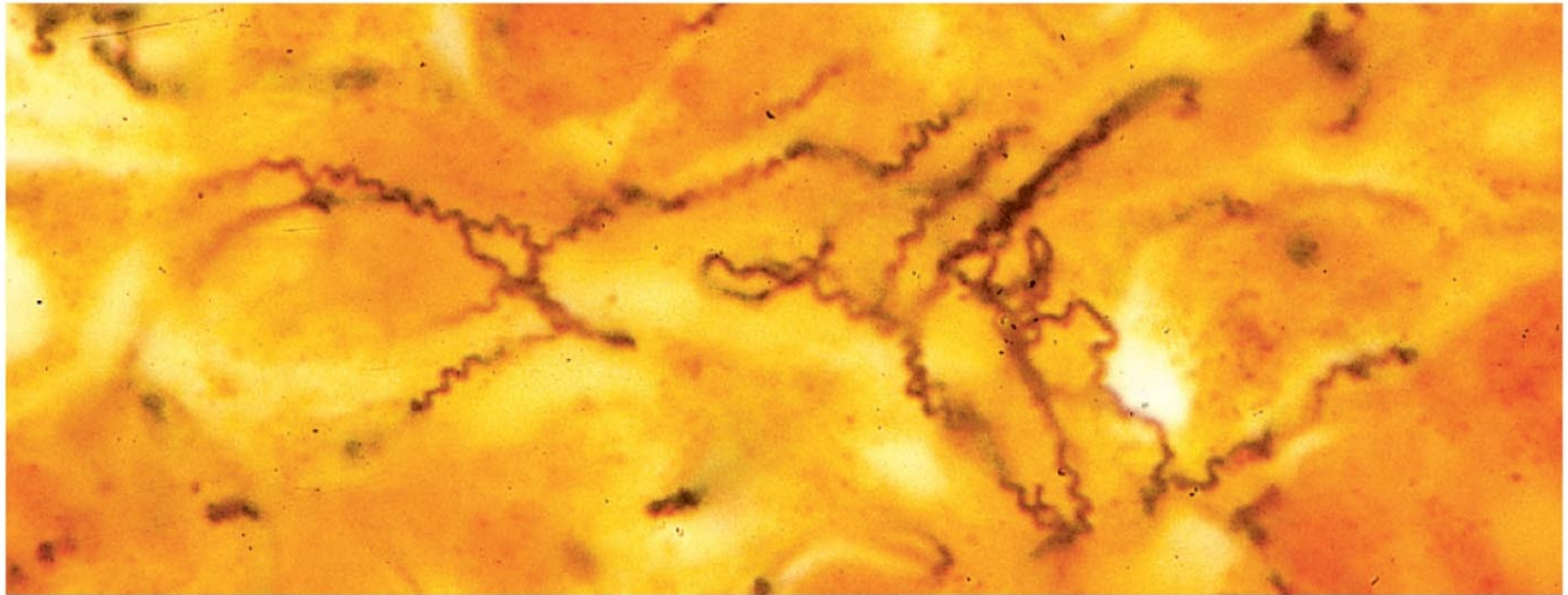
Figure 26.8 Salpingitis



Syphilis (1 of 4)

- Caused by **Treponema pallidum**
 - Gram-negative spirochete
 - Grows slowly in cell culture
- Invades the mucosa or through skin breaks and enters the bloodstream
- Induces an inflammatory response
- Some strains cause **yaws**
 - Skin disease is not sexually transmitted
- Stable incidence in the United States

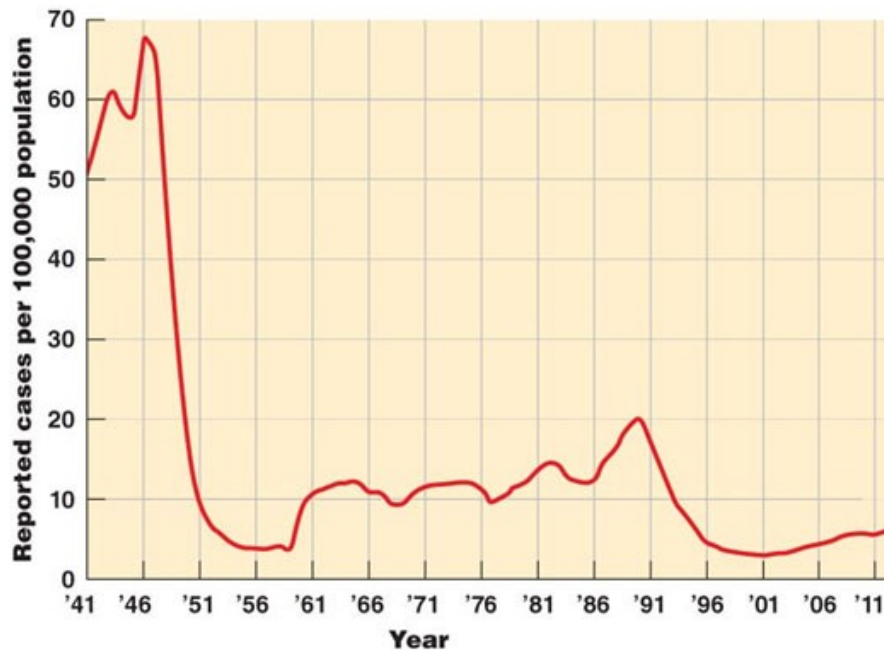
Figure 26.9 Treponema Pallidum, the Cause of Syphilis



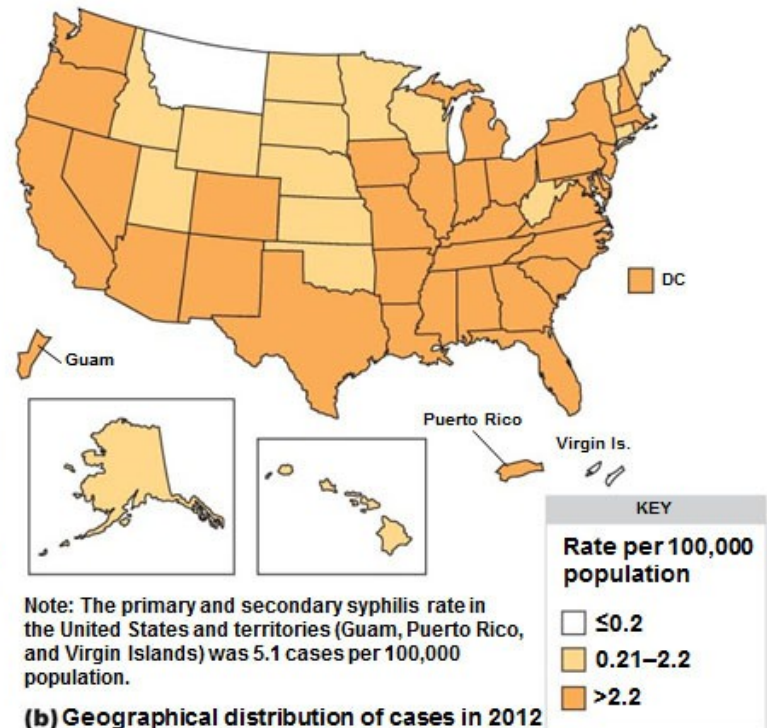
LM

2 μ m

Figure 26.10 The U.S. Incidence and Distribution of Primary and Secondary Syphilis



(a) Incidence of syphilis in the United States, 1941–2013



Syphilis (2 of 4)

- Primary stage
 - **Chancere** at the site of infection about 3 weeks after exposure
 - Painless and highly infectious
 - Disappears after 2 weeks
- Secondary stage
 - Skin and mucosal rashes, especially on the palms and soles
 - Due to an inflammatory response
- Latent period
 - No symptoms

Syphilis (3 of 4)

- Tertiary stage
 - Appear years after latency
 - Due to cell-mediated immune reactions
 - Gummatous syphilis: **gummas** on many organs
 - Cardiovascular syphilis: weakens the aorta
 - Neurosyphilis: affects the CNS; dementia
- **Congenital:** neurological damage to the fetus

Figure 26.11 Characteristic Lesions Associated with Various Stages of Syphilis



(a) Chancre of primary stage on a male in genital area



(b) Lesions of secondary syphilis rash on a forearm; any surface of the body may be afflicted with such lesions.



(c) Gummas of tertiary stage on the back of a forearm; gummas such as these are rarely seen today in the era of antibiotics.

Syphilis (4 of 4)

- Microscopic tests
 - **Direct fluorescent-antibody test (DFA-TP)** with monoclonal antibodies
- Nontreponemal serological tests
 - Slide agglutination **VDRL test**
 - **Rapid plasma reagin (RPR) test**
- Treponemal-type serological tests
 - **Enzyme immunoassay (EIA)**
 - **Fluorescent treponemal antibody absorption test (FTA-ABS)**
- Treatment with benzathine penicillin

Lymphogranuloma Venereum (LGV)

- Caused by **C. trachomatis**
- Infects the lymphoid tissue
 - Regional lymph nodes become enlarged and tender
 - Discharge of pus and scarring
- Diagnosis with blood test for antibodies to the organism
- Treatment with doxycycline

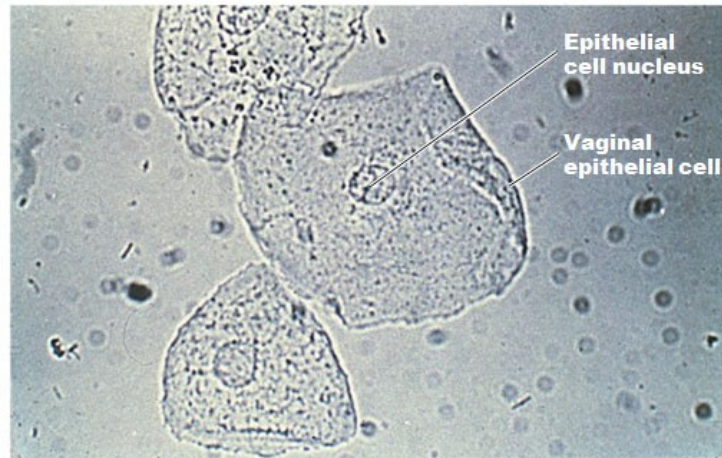
Chancroid (Soft Chancre)

- Caused by **Haemophilus ducreyi**
 - Gram-negative rod
- Associated with drug use
- Painful ulcers of the genitals and swollen lymph nodes in the groin
 - Factors in the sexual transmission of HIV
- Treatment with azithromycin or ceftriaxone

Bacterial Vaginosis

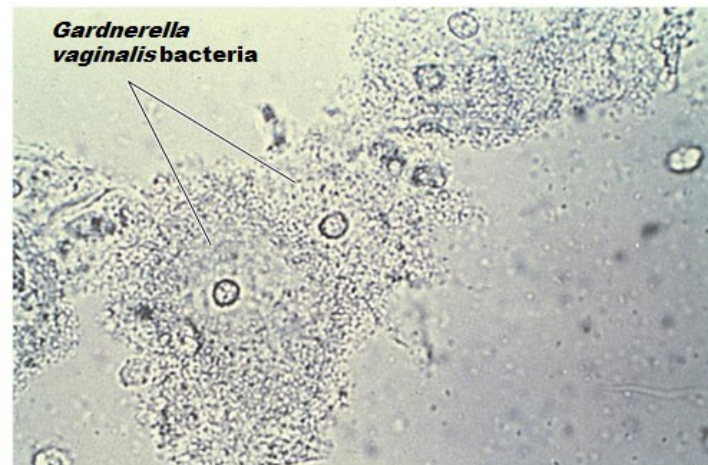
- Caused by **Gardnerella vaginalis**
 - Pleomorphic gram-negative rod
- **Vaginitis:** inflammation of the vagina due to infection
- **Vaginosis:** no sign of inflammation
- pH above 4.5, fishy odor, copious frothy discharge
- Clue cells
 - Sloughed-off vaginal epithelial cells covered with a biofilm of **G. vaginalis**

Figure 26.12 Clue cells



(a) Normal vaginal epithelial cell

LM 12.5 μm



(b) Clue cell

LM 12 μm

Check Your Understanding-5

Check Your Understanding

- ✓ Why is the disease condition of the female reproductive system, principally featuring growth of **Gardnerella vaginalis**, termed **vaginosis** rather than vaginitis?

26-6

Viral Diseases of the Reproductive Systems

Learning Objective

26-7 Discuss the epidemiology of genital herpes and genital warts.

Genital Herpes

- Caused by herpes simplex virus type 2 (HSV-2)
 - In the United States, 1 in 4 over age 30 are infected
- Painful vesicles on the genitals; painful urination
 - Heals within 2 weeks
- Recurrences from viruses latent in nerve cells
 - Due to menstruation, emotional stress, or illness
- Diagnosis via culture or PCR
- No cure; suppression and management with acyclovir, famciclovir, and valacyclovir

Figure 26.13 Genital Herpes: Initial Visits to Physicians' Offices, United States, 1966 to 2012

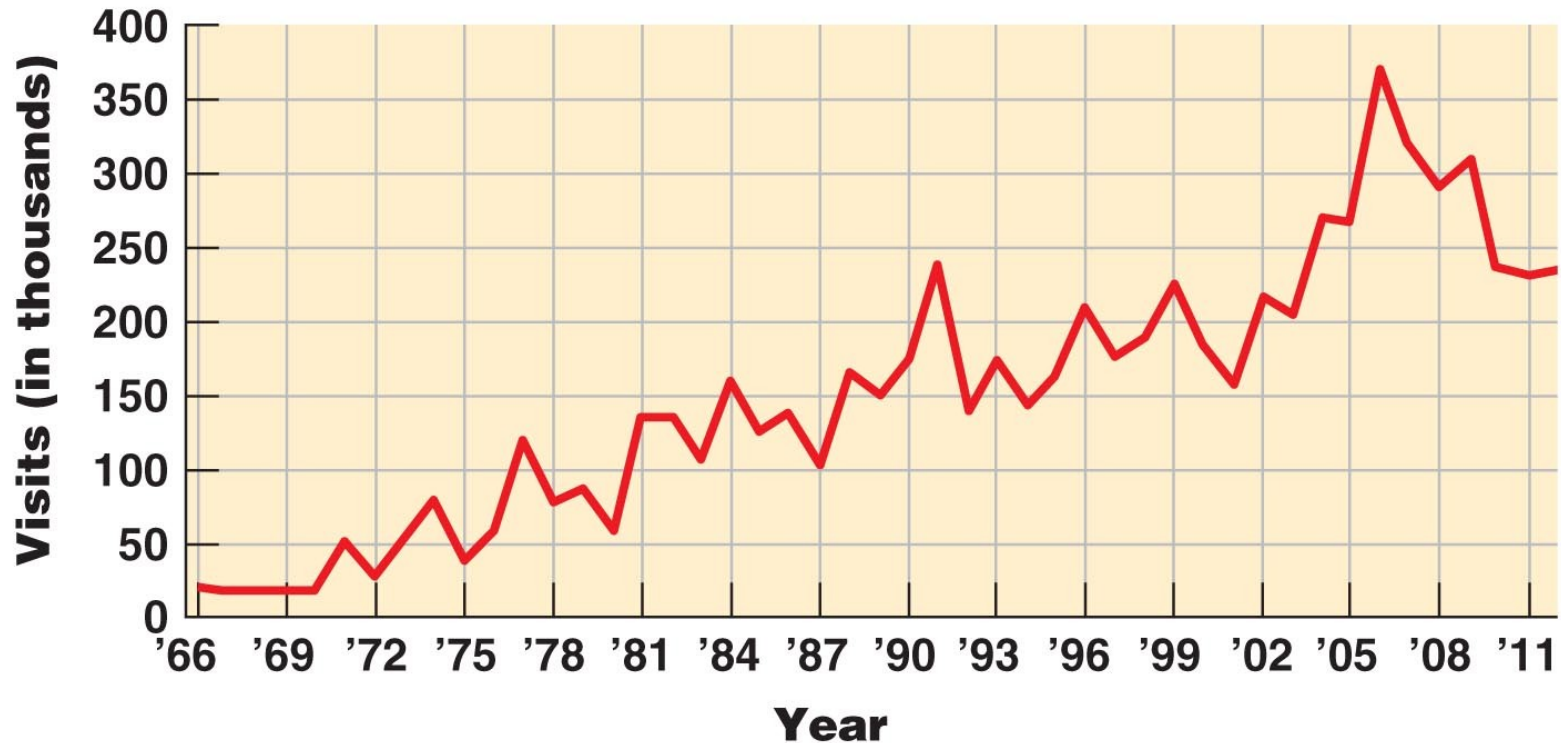
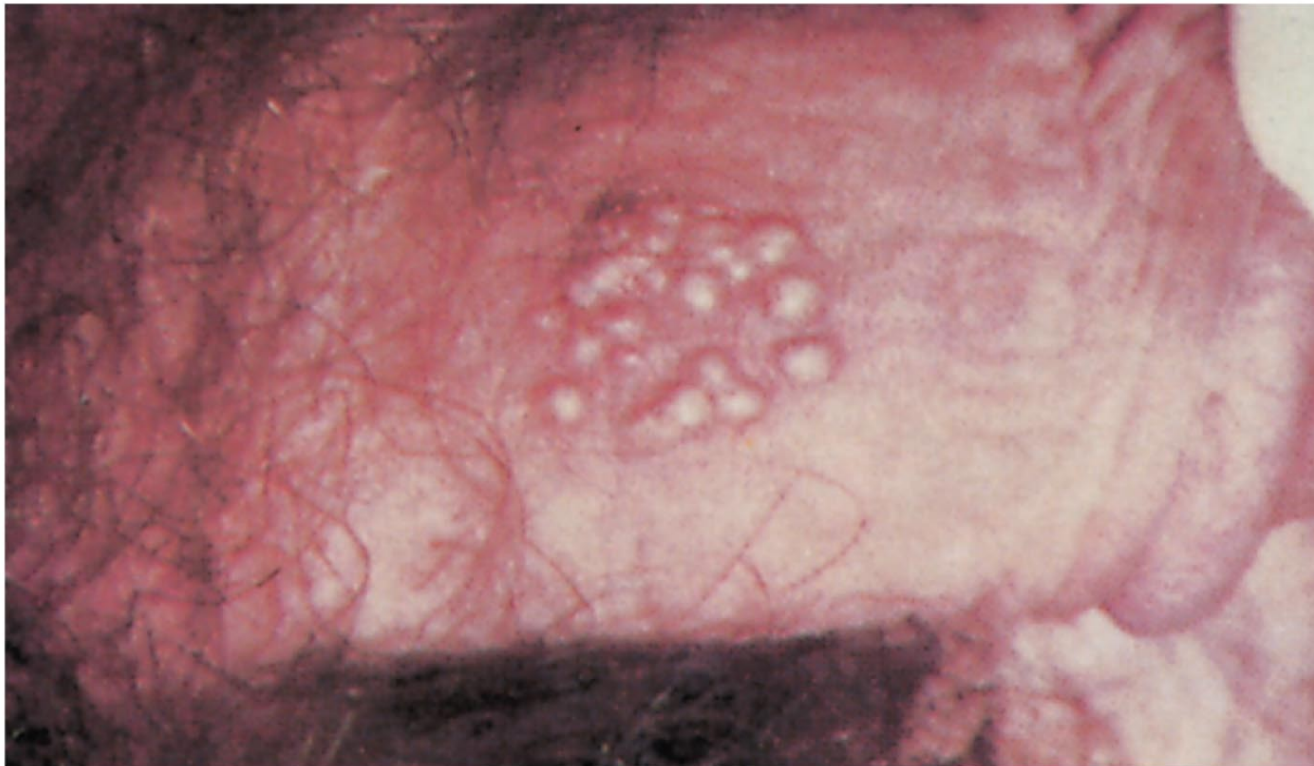


Figure 26.14 Vesicles of Genital Herpes on a Penis



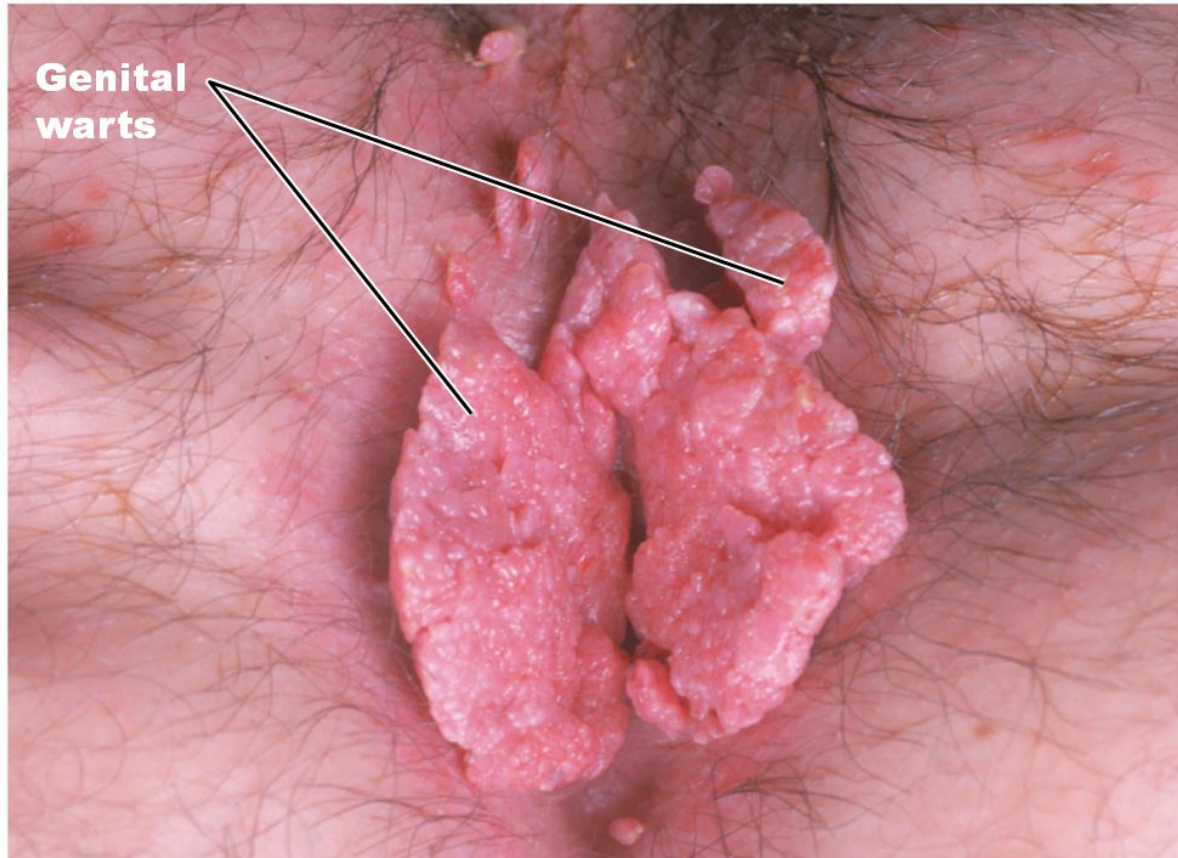
Neonatal Herpes

- Herpesvirus crosses the placental barrier and infects the fetus
 - Damages the CNS, developmental delays, blindness, hearing loss
- Survival rate of 40%
- Newborns infected from HSV exposure during delivery
- Diagnosed by PCR tests and fluorescent antibody tests
- Treatment with intravenous acyclovir

Genital Warts

- Also known as condyloma acuminata
- Caused by human papillomaviruses
- 25% of 14- to 59-year-old women in the United States are infected
- Visible warts caused by serotypes 6 and 11
- Serotypes 16 and 18 cause cervical cancer
 - Kills 4000 women in the United States annually
- Treatment via removal of warts; podofilox and imiquimod
- Prevention with the Gardasil and Cervarix vaccines

Figure 26.15 Genital Warts on a Vulva



Check Your Understanding-6

Check Your Understanding

- ✓ Both genital herpes and genital warts are caused by viruses; which one is the greater danger to a pregnancy?
26-7

Fungal Disease of the Reproductive Systems

Learning Objective

26-8 Discuss the epidemiology of candidiasis.

Candidiasis

- Caused by **C. albicans**
 - Grows on the mucosa of the mouth, the intestinal tract, and the genitourinary tract
 - Due to opportunistic overgrowth caused by:
 - Antibiotic use
 - Diabetes
 - Hormones
- **Oral candidiasis:** thrush
- **Vulvovaginal candidiasis:** vaginitis
- Yeasty, thick, yellow discharge
- Treatment with clotrimazole or fluconazole

Check Your Understanding-7

Check Your Understanding

- ✓ What changes in the vaginal bacterial microbiota tend also to favor the growth of the yeast **Candida albicans**?

26-8

Protozoan Disease of the Reproductive Systems

Learning Objectives

26-9 Discuss the epidemiology of trichomoniasis.

26-10 List reproductive system diseases that can cause congenital and neonatal infections, and explain how these infections can be prevented.

Trichomoniasis

- Caused by **Trichomonas vaginalis**
 - Normal inhabitant of the vagina and urethra
- Grows when normal acidity of the vagina is disturbed
- Irritation and a profuse foul, greenish yellow frothy discharge
- Diagnosis with microscopic identification or a DNA probe
- Treatment with metronidazole

Figure 26.16 *Trichomonas vaginalis* Adhering to the Surface of an Epithelial Cell in a Cell Culture Preparation



The TORCH Panel of Tests

- Panel of tests that screens for antibodies to infections in pregnant women
- **T**oxoplasmosis
- **O**ther (such as syphilis, hepatitis B, enterovirus, Epstein-Barr virus, varicella-zoster virus)
- **R**ubella
- **C**ytomegalovirus
- **H**erpes simplex virus

Diseases in Focus: Microbial Diseases of the Reproductive System

- A 26-year-old woman has abdominal pain, painful urination, and fever. Cultures grown in a high-CO₂ environment reveal gram-negative diplococci.
- Can you identify infections that could cause these symptoms?

Diseases in Focus 26.3 (1 of 3)



Diseases in Focus 26.3 (2 of 3)

Disease	Pathogen	Pathogen	Treatment
BACTERIAL DISEASES			
Gonorrhea	Neisseria gonorrhoeae	Men: painful urination and discharge of pus. Women: few symptoms but possible complications, such as PID.	Cephalosporins
Nongonococcal Urethritis (NGU)	Chlamydia trachomatis, Mycoplasma hominis, Ureaplasma urealyticum	Painful urination and watery discharge. In women, possible complications, such as PID.	Doxycycline, azithromycin
Pelvic Inflammatory Disease (PID)	N. gonorrhoeae, C. trachomatis	Chronic abdominal pain; possible infertility	Doxycycline and cefoxitin
Syphilis	Treponema pallidum	Initial sore at site of infection, later skin rashes and mild fever; final stages may be severe lesions, damage to cardiovascular and nervous systems.	
Lymphogranuloma Venereum (LGV)	C. trachomatis	Swelling in lymph nodes in groin	Doxycycline
Chancroid (Soft Chancre)	Haemophilus ducreyi	Painful ulcers of genitals; swollen lymph nodes in groin	Erythromycin; ceftriaxone
Bacterial Vaginosis	See Diseases in Focus 26.2 page 764		

Diseases in Focus 26.3 (3 of 3)

Disease	Pathogen	Pathogen	Treatment
VIRAL DISEASES			
Genital Herpes	Herpes simplex virus type 2; HSV type1	Painful vesicles in genital area	Acyclovir
Genital Warts	Human papillomaviruses		
AIDS	See Chapter 19, pp. 534-544		
FUNGAL DISEASE			
Candidiasis	See Diseases in Focus 26.2, page 764		
PROTOZOAN DISEASE			
Trichomoniasis	See Diseases in Focus 26.2, page 764		

Check Your Understanding-8

Check Your Understanding

- ✓ What are the symptoms of the presence of **Trichomonas vaginalis** in the male reproductive system?
26-9
- ✓ What is the intent of the TORCH panel of tests? 26-10